

We conclude this section with a summary of the differentiation rules studied so far. To become skilled at differentiation, you should memorize each rule.

Summary of Differentiation Rules

General Differentiation Rules

Let f , g , and u be differentiable functions of x .

Constant Multiple Rule:

$$\frac{d}{dx}[cf] = cf'$$

Product Rule:

$$\frac{d}{dx}[fg] = fg' + gf'$$

Constant Rule:

$$\frac{d}{dx}[c] = 0$$

$$\frac{d}{dx}[\sin x] = \cos x$$

$$\frac{d}{dx}[\cos x] = -\sin x$$

Chain Rule:

$$\frac{d}{dx}[f(u)] = f'(u) u'$$

Sum or Difference Rule:

$$\frac{d}{dx}[f \pm g] = f' \pm g'$$

Quotient Rule:

$$\frac{d}{dx}\left[\frac{f}{g}\right] = \frac{gf' - fg'}{g^2}$$

(Simple) Power Rule:

$$\frac{d}{dx}[x^n] = nx^{n-1}, \quad \frac{d}{dx}[x] = 1$$

$$\frac{d}{dx}[\tan x] = \sec^2 x \quad \frac{d}{dx}[\sec x] = \sec x \tan x$$

$$\frac{d}{dx}[\cot x] = -\csc^2 x \quad \frac{d}{dx}[\csc x] = -\csc x \cot x$$

General Power Rule:

$$\frac{d}{dx}[u^n] = nu^{n-1} u'$$

Derivatives of Algebraic Functions

Derivatives of Trigonometric Functions

Chain Rule

STUDY TIP As an aid to memorization, note that the cofunctions (cosine, cotangent, and cosecant) require a negative sign as part of their derivatives.

EXERCISES FOR SECTION 2.4

In Exercises 1–6, complete the table using Example 2 as a model.

$y = f(g(x))$	<i>Peanut</i> $u = g(x)$	<i>Shell</i> $y = f(u)$
1. $y = (6x - 5)^4$		
2. $y = \frac{1}{\sqrt{x+1}}$		
3. $y = \sqrt{x^2 - 1}$		
4. $y = 3 \tan(\pi x^2)$		
5. $y = \csc^3 x$		
6. $y = \cos \frac{3x}{2}$		

In Exercises 7–34, find the derivative of the function.

7. $y = (2x - 7)^3$ 8. $y = (2x^3 + 1)^2$
 9. $g(x) = 3(4 - 9x)^4$ 10. $y = 3(4 - x^2)^5$
 11. $f(x) = (9 - x^2)^{2/3}$ 12. $f(t) = (9t + 2)^{2/3}$
 13. $f(t) = \sqrt{1 - t}$ 14. $g(x) = \sqrt{5 - 3x}$

15. $y = \sqrt[3]{9x^2 + 4}$

17. $y = 2\sqrt[4]{4 - x^2}$

19. $y = \frac{1}{x - 2}$

21. $f(t) = \left(\frac{1}{t - 3}\right)^2$

23. $y = \frac{1}{\sqrt{x + 2}}$

25. $f(x) = x^2(x - 2)^4$

27. $y = x\sqrt{1 - x^2}$

29. $y = \frac{x}{\sqrt{x^2 + 1}}$

31. $g(x) = \left(\frac{x + 5}{x^2 + 2}\right)^2$

33. $f(v) = \left(\frac{1 - 2v}{1 + v}\right)^3$

16. $g(x) = \sqrt{x^2 - 2x + 1}$

18. $f(x) = -3\sqrt[4]{2 - 9x}$

20. $s(t) = \frac{1}{t^2 + 3t - 1}$

22. $y = -\frac{5}{(t + 3)^3}$

24. $g(t) = \sqrt{\frac{1}{t^2 - 2}}$

26. $f(x) = x(3x - 9)^3$

28. $y = \frac{1}{2}x^2\sqrt{16 - x^2}$

30. $y = \frac{x}{\sqrt{x^4 + 4}}$

32. $h(t) = \left(\frac{t^2}{t^3 + 2}\right)^2$

34. $g(x) = \left(\frac{3x^2 - 2}{2x + 3}\right)^3$